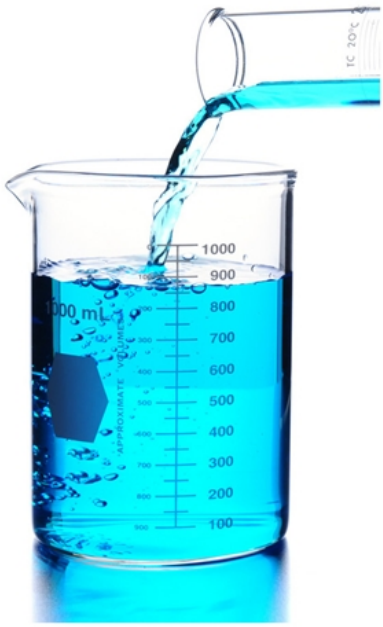
Five things you should know when mixing your own hydroponic liquid nutrients

Many hydroponic growers – especially large scale ones – can benefit greatly from mixing their own custom nutrients. Not only can this save money in the thousands of dollars per month but it can also give you an unprecedented degree of control when compared with store-bought nutrients. On today's post I am going to write about five important things you should know when mixing your own nutrients so you can avoid many common problems that can arise when you start preparing your own stock solutions.



More concentrated solutions are not always better. When you prepare a concentrated liquid you would usually want to go with the highest possible concentration factor so that you can prepare as much final nutrient solution as possible with as little stock solution as possible. However trying to get into higher concentration factors (1:400-1:500) can cause important issues due to the solubility of the salts used and the

temperatures the stock solution will be exposed to. It can also cause high inaccuracies with variable injector setups since the dilutions will be much smaller. For starters go with a 1:100 concentration factor and only start going higher when you get more experience. If you're using injectors I would generally avoid a range higher than 1:250 unless you do more extensive calibration procedures with your injectors.

Impurities can cause important problems. Some salts can come with significant levels of impurities – sometimes mainly additives – that can cause substantial issues when preparing your nutrient solutions. Lower quality grade salts – mainly those used for soil fertilization or those that are OMRI listed and come straight from mining with no refining – can generate problems within your mixing process. These problems range from insoluble left-overs in tanks to toxic amounts of some micro elements. To ensure you get the best possible results use greenhouse grade fertilizer salts and try to avoid sources of salts that are OMRI listed. Synthetic sources that have been heavily purified are your best bet in ensuring the best possible results.

Use slightly acidic deionized water to prepare the solutions. Most water sources in Europe and the US are very heavy in carbonates an therefore inappropriate for the preparation of concentrated nutrient solutions as these ions can cause salts to precipitate when preparing concentrated solutions. To fix this issue the best thing would be to use distilled water but – since this is often not an option – the next best thing is to use reverse osmosis water and add a bit of acid (0.5mL/L of nitric acid, other acids may cause other problems) per gallon of concentrated solution. This will ensure that everything gets dissolved and will eliminate the carbonates that can be naturally present within the water. *Of course never, ever use tap or well water to prepare concentrated hydroponic solutions*.

Salts take up volume, take that into account. A very common

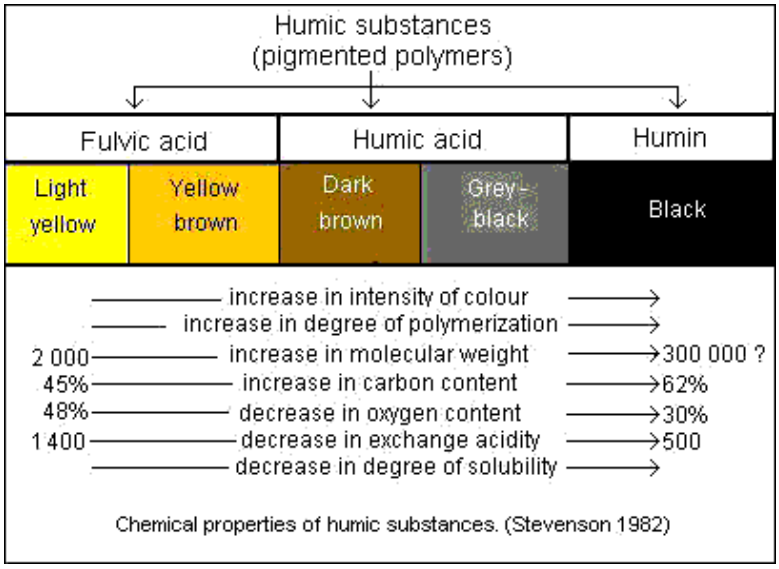
mistake when preparing solutions is to just add the salts to the final volume of desired stock solution to prepare. This is a mistake since the salts also take up volume. If you want to prepare 1 liter of concentrated solution and you need to add say, 100 g of potassium nitrate, adding 100g of potassium nitrate to 1L of water would generate a solution with a final volume greater than 1L. To avoid this problem always add the salts to half the volume of water and, after the salts have dissolved, complete to the final volume of desired solution.

Add salts from the smallest to the largest quantities. When you prepare hydroponic solutions it is often better – especially when you're starting – to add salts from the smallest to the highest amounts needed. If you make a mistake at some point then you will minimize the amount of mass of salts that has been wasted due to this fact. If you make a mistake adding a micro nutrient you will only lose a small amount of the other micro nutrients instead of losing a huge amounts of macro nutrients due your order of addition. It is also true that the substances that are added in largest quantities are commonly nitrates and these salts have endothermic dissolutions – meaning they cool solutions upon addition – so it is better to add them last so that they can benefit a bit from the heat generated by the dissolution of the other salts.

The above is not an exhaustive list of pointers but it should save you from some important trouble when preparing your own initial nutrient solutions.Although some of these points may seem obvious to those that have experience preparing their own solutions they may prove invaluable to those who are just starting their journey in concentrated nutrient preparation.

Humic acids in hydroponics: What is their effect?

Plants and microorganisms affect the substrates in which they grow in many ways. If you start growing plants in an inert substrate – with nutrient applications of course – you will notice that the substrate's chemical composition will start to change with time and it will start to get enriched in carbon containing substances. As plants and microorganisms grow, thrive and die, some of the chemicals that made up their cells end up enriching the substrate they grow on. This process – whereby organic materials from living organisms become part of a substrate – is what generates the soils around us. One of the most prevalent class of components in this organic material, is what we call humic acids.



Humic substance chemical properties.

Humic acid is not a single substance but a wide range of substances that are created as a product of plant and microorganism decomposition. This is why you often hear people talk about "humic acids" instead of simply "humic acid". They are called "acids" because the humic substances contain molecules that have groups that resemble those found in phenol and vinegar. They are also differentiated from fulvic acids in

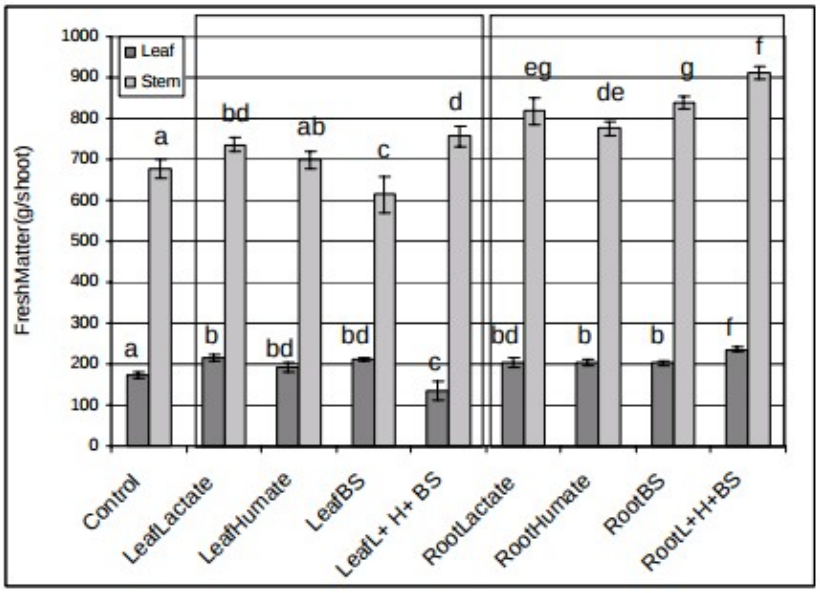
the fact that they are only soluble at basic pH values while fulvic acids are generally small enough molecules to be soluble across most of the pH spectrum. Since humic acids are a very important component of enriched soils and can be used in soiless culture, people have started using them as supplements in soiless and pure hydroponic culture.

When talking about the effects of humic acids it is worth mentioning that since we're talking about a group of molecules – not a single substance – effects are generally dependent on the source of the humic acid used. For example you can find a study on tomatoes here where two different sources of humic acids – from peat and leonardite – were used to grow tomatoes. The study shows a clear difference between both with the first only stimulating root growth while the second stimulated both roots and shoots. However in both cases there was an increased iron availability to plants, although the mechanism for this was not established.

Tomato plants inoculated with root rot at different humic acid application rates

In plants like gerberas humic acids applied at 1000 ppm can offer increases in harvested flowers of up to 52% (see here), somewhat positive effects can also be seen in tomatoes across the literature with most studies showing increases in yields and mineral contents (see here), reports of positive effects on gladiolus have also been published (here). Since the 1990s there has been a somewhat established understanding of some

general beneficial effects for humic acid applications, it is well established that they can prevent and eliminate micro nutrient deficiencies due to their abilities to increase their availability(see here). The literature is also quite consistent in that the largest effects are often seen on root growth rather than on shoot growth or mass. There are however some types of humic acids that have showed higher increases of shoot mass, for example in an article studying humic substances derived from municipal waste on barley this was the observed effect. For some plants however – despite these beneficial effects – increases in yields in hydroponic culture are not evident (see here and here). A look at the effect of a humic acid source on several different plant species can be found here.



Effect of humic acid, bacteria and lactate applications on tomato plants.

It is worth noting that humic acid applications are also not limited to the root zone. Since humic acids can enhance the absorption of some nutrients they can also be applied in foliar sprays. Experiments on strawberries (here) showed that an application of 1.5-3ppm of humic acids led to an increase in the quantitative and qualitative properties of the fruits. Combinations of humic acids with other biostimulants are also

common. For example a combinations of lactate, humate and beneficial bacteria was tested on tomatoes (here) but the experiments showed that the effect could be stimulating or inhibiting depending on the particular conditions, even though most combinations were beneficial.

With the high variability between humic substance origins, application rates and effects it is very hard to say whether humic acid applications will definitely help your crops in terms of yields. For almost all humic acid sources it is probably warranted that micronutrient absorption will be somewhat augmented due to their ability to chelate these nutrients, but only if the nutrients are not efficiently chelated already. This sole ability might lead to crop improvements if deficiencies are present but improvements in yields will strongly depend on humic acid substance origin and particular properties. However humic acids do seem to lead to general product quality improvements and since negative effects are rare there seems to be no harm in carrying out field tests to determine if their use is worth it for your particular crop.

How to prevent problems with powdery mildew in hydroponic crops

One of the worst problems you can get in a hydroponic crop is mildew. Year after year I see growers lose significant amounts of production due to this disease within a variety of different crops. Powdery mildew reduces yields, stunts plants and – if contracted early on – will possibly cause a complete

loss of your crop. It is generally hard to control once it gets in and it will expand like wildfire through any commercial growing operation. Today we will be discussing how to actually prevent mildew from ever appearing – without using toxic fungicide applications – and why prevention can play a huge role in ensuring you never have to face this problem in the first place.

Fungal spores are generally carried by the wind and by insects, making it very hard for a crop to avoid ever coming into contact with the pathogen. Wild plants or plants from other commercial crops close to you will most likely have the disease and millions of spores will get in the air and eventually reach your plants. It is only a matter of time till the powdery mildew reaches your crops – almost impossible to prevent – so you must make sure that your plants are strong enough to prevent the pathogen from taking hold.

There are two main factors that affect whether powdery mildew will infect your plants. The first is plant strength and the second is the environment. If one of these two is not at its best then your plants will fall prey to this fungal disease. Neither strong plants under bad environmental conditions nor weak plants under ideal environmental conditions will be safe from the disease. So what can we do to ensure our plants are healthy and our environmental conditions are safe?

One of the proven methods to make plants strong against fungi is silicon. Potassium silicate applications – as soil drenches or foliar sprays – have proven to increase disease resistance across several studies (see here and here for examples). But other innovative approaches using other forms of silicon – for example nanometer sized silica crystals – have also yielded good results. In this and this studies it was clearly shown that other forms of silicon – besides silicate – could also help in preventing fungal disease. This might be preferred in some cases as these forms of silicon can be far more stable and easier to store/apply compared with options like potassium silicate.

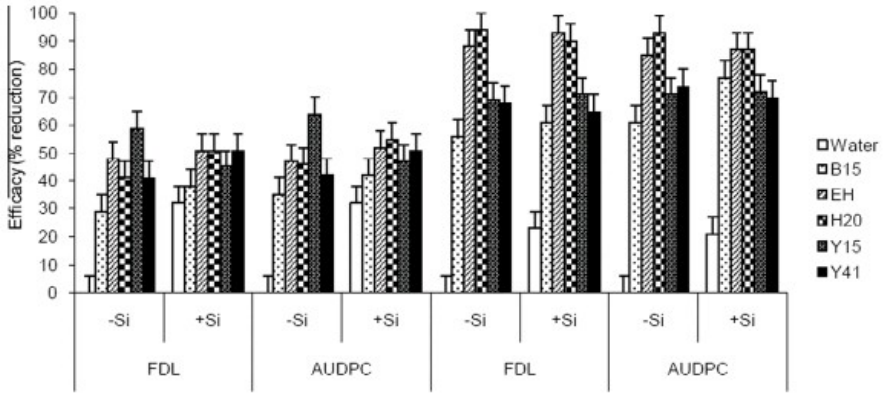


Fig. 1. Efficacy of biocontrol agents [*Clonostachys rosea* (EH), *Serratia marcescens* (B15, Y15 and Y41) and *Trichothecium roseum* (H20)] and silicon in reducing the severity of powdery mildew of greenhouse grown zucchini 5 weeks after inoculation with *Podosphaera xanthii* in two experiments.

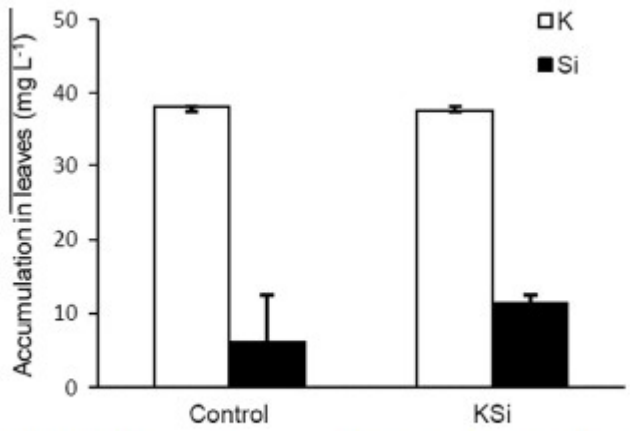


Fig. 3. Effects of K_2SiO_2 application on the accumulation of silicon (Si) and potassium (K) in leaves of zucchini after 5 weeks of treatment at 100 mg L^{-1}.

However silicate applications are no miracle. If your environmental conditions are not set properly the silicate

applications will be useless. This is the reason why some growers say that silicate does nothing against disease, because an environment that's favorable for fungi can basically nullify the protective action of supplemental silicon. This was demonstrated by cucumber growers who had a lot of success with Si supplementation in Canada to prevent fungal diseases, but failed to reproduce this success in Florida. A study about this difference revealed that the higher temperatures in Florida negated a large part of the benefits from silicon supplementation. If you want silicon to work against disease better stay in the 20-25°C range.

Other microorganisms can also be of great help in preventing powdery mildew. If a leaf is already colonized by beneficial fungi or bacteria it will be much harder for a pathogen to get in. Several species of microorganisms have been studied in this regard. Fungi like Tilletiopsis have shown to prevent and control the disease (see here), other microbes have also been studied in conjunction with silicon (see here and here), showing beneficial effects. Fungus like Trichoderma harzianum and bacteria like bacillus subtilis have also shown induction of systemic resistance against fungal diseases (see here, here and here). The two images above were taken from this study.

Friendly chemical solutions are also available for the prevention of powdery mildew. Plant derived extracts, for example neem seed oil at 1% has shown to be a good agent for powdery mildew prevention in okra (see here). Substances like salicylic acid have also shown to trigger resistance to powdery mildew in plants like peas (see here).

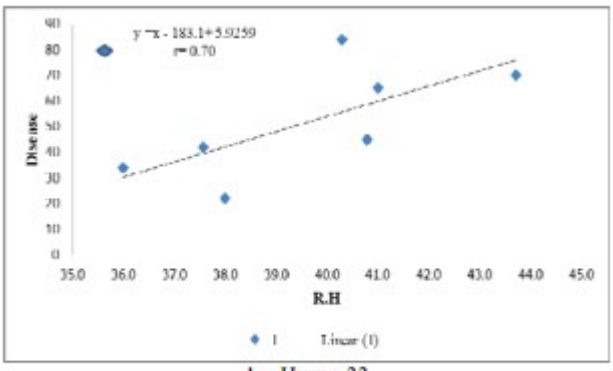


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Fig 2.3: Relationship of Relative Humidity with Powdery Mildew Disease Severity.

There are also additional alternatives dealing with the environment that can make it difficult for fungi to colonize plants by attempting to make the environment more hostile for fungi. Spraying ozonated water has shown positive results in experiments with tomatoes (see here) as well as electrolyzed water in strawberries (see here). Keeping the environment conditions within a proper range is also important, this paper shows you how environmental conditions affect powdery mildew disease severity in sunflower but the general features are applicable to most higher plants. As you can see in the image above – taken from this paper – disease severity increases with relative humidity. In general you will want to keep your relative humidity below 70% to avoid making the environment extremely friendly for fungi.

In the end there are many things you can do to keep your plants free of foliar fungal disease like powdery mildew. Use lower temperatures, control your relative humidity, do silicate and salicylic acid applications and use beneficial microbes. If you follow these steps you will forget that powder mildew ever existed!